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HOME MIXED FERTILIZERS.

This Bulletin contains the report of cooperative experiments with farmers upon home mixing, and suggested formulas for a few of the more common crops.

Requests for bulletins should be addressed to the
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HOME MIXED FERTILIZERS.

CHAS. D. WOODS.

Commercial fertilizers have been commonly employed for more than a generation and in that time there has been comparatively little advance made by the farmer in their use. Where money crops are grown it has become the custom of many successful growers to fertilize liberally, with only slight regard to the needs of the crop and the fertility of the land. For instance, in Aroostook County the growers of potatoes have found that it pays to use large amounts of commercial fertilizers upon this crop, and one finds farmers applying 1000 to 1800 pounds of a high grade fertilizer to the acre without reference to the preceding crop, either in the choice of the kind of fertilizer or the amount to be used.

When commercial fertilizers were first placed upon the market, there was a good deal of excuse for its unwise and wasteful use. While it is not a simple matter, for even the most expert, to always correctly apply the principles of feeding plants to field practice, and while many conditions such as season, tilth, and other circumstances arise both within and beyond the control of the grower, the principles underlying the production and maintenance of soil fertility have been so clearly and frequently stated, that there is comparatively little excuse for slipshod practice in the purchase and use of commercial plant food. The subject of the intelligent use of farm manures and commercial fertilizers is too large to be entered upon at this time and place. Many valuable, readable and readily understood books have been written upon this subject and can be had from any book dealer at prices within the reach of all. Farmers' Bulletin 44, of the United States Department of Agriculture, takes up in a concise manner the composition and use of commercial fertilizers. By applying to your Congressman or to the Secretray of Agriculture, Washington, D. C., a copy may be had free. A little book on "Manures: How to Make and How to Use Them," pub-

lished by the seedsmen, W. Atlee Burpee and Company, Philadelphia, is a comprehensive book that costs 50 cents; and Professor Voorhees' treatise on Commercial Fertilizers, published by Macmillan and Company, New York, for \$1.00, gives a clear and not very technical presentation of the principles underlying the use of the different kinds of plant food for different crops and soils. If one feels that because of ignorance it would be better to buy ready mixed goods than to attempt home mixing, it must be remembered that there is little if any more likelihood of making mistakes in the proportions when mixing than there is of buying ready mixed goods unsuited to the purpose. A farmer complained this year about a fertilizer that he used for potatoes and inquiry revealed the fact that he had used on land in poor condition a fertilizer intended for seeding down, which carried very little nitrogen and with almost none of its constituents in a readily available form. It is difficult to believe that one purchasing and mixing chemicals for the first time would have made such a serious mistake, in the forms and proportions of plant food.

WHY USE HOME MIXED GOODS.

The reasons for and against home mixing are few and easily stated.

In general, if considerable quantities of fertilizers are used, there can be a considerable saving in the purchase.

When separate materials are purchased there is less likelihood of being deceived. This does not apply, however, with very great force when the goods are purchased from the well known and reliable manufacturers.

In home mixing the farmer can readily change the mixture so as to more nearly adapt it to the requirements of different crops. While the manufacturers do this to a considerable extent, it rarely happens that a farmer growing several kinds of crops takes advantage of this fact. He usually employs the same brand regardless of the crop, whether grown on a clover turf or with or without farm manure. This leads to the most important reason of all for home mixing, stated in the next paragraph.

There is a great educational value in home mixing. The use of an unknown mixture gives little information, and the farmer that has for years used ready mixed goods knows but little more as to the needs of his land and crops than when he began. The

purchase of unmixed goods will lead to an intelligent use. It is impossible to imagine an intelligent man using unmixed goods on different crops and soils through a series of years without coming to a fairly clear understanding of the chemical needs of the soil and crops, even though he may know nothing of the principles of chemistry. It is furthermore equally difficult to conceive of such a man using unmixed goods year after year without being impelled to study and to read. Just as hundreds of skilled, intelligent feeders have been developed by reading, study, experiment and observation, so equally scientific users and conservers of plant food would be the result of intelligent home mixing.

Two reasons are commonly advanced against home mixing:—

On small purchases there is little or no saving. This is a matter of dollars and cents, and inquiry as to cost of materials, and the same *weights of plant food* ready mixed, will enable any one to answer the question of economy for himself.

It is also claimed that owing to the lack of proper facilities the farmer can not mix as well as the manufacturers. That he can do so with a tight barn floor, and no other implements than a shovel, a screen and a rake has been shown over and over again in every state in the East and South.

A MANUFACTURER'S VIEW OF HOME MIXING.*

“As to mixing at home, they who do it cannot readily obtain their materials at first hand or in an absolutely raw condition. In the first place, the phosphate or bone must be ground and treated with sulphuric acid if available or soluble phosphoric acid is desired. This cannot be done on the farm. The tank-ages, blood or fish must also be ground for home mixing, also the chemicals, for most of them come in a lumpy condition and need remilling. For this expense of preparation the home mixer must of necessity pay some one, for it is a part of the cost of manufacture. In fact it is the larger part, for when the raw materials are prepared, the phosphates ground and acidulated, and the other materials put into a fine mechanical condition the most important and costly steps in the process of manufacture have been taken. The last step, of putting them together, is the least expensive of them all.

* Extracts from a personal letter.

"There may be a few farmers who can figure out a saving by home mixing, but this is not the case with the great mass of farmers; and even if the home mixers constituted the great mass they would not be able to get their goods direct but would have to take them through distributing agencies in order to secure them in time. In any event, they must pay for the preparation of the materials, freights, bags, and to this cost will also be added a certain percentage for losses and shrinkage, whether they buy the mixed or the unmixed goods; and finally they must pay a profit, for all business is based on a fair return.

"I have never objected to home mixing and to the Experiment Stations urging it for I know that through it many farmers who have not used chemicals will be led to use them and will eventually become large users of mixed fertilizers. I consider it an excellent educational process and a good introduction to the use of mixed manures. Some of our best customers for complete fertilizers, I may say *the* best customers that we have ever had began as home mixers."

IS HOME MIXING PRACTICABLE?

To make it evident that Maine farmers do and can mix goods that are in all particulars equal to the best factory mixed, the Station made in 1904 cooperative experiments upon home mixing with farmers in Brunswick, Houlton and Fort Fairfield (Maple Grove).

The completeness of the mixing is illustrated by the following: A number of farmers at Brunswick clubbed together and purchased bone tankage, cottonseed meal, nitrate of soda, acid phosphate and sulphate of potash. The tankage was not in as good mechanical condition as was desirable but this was remedied by passing it over a screen with 3 meshes to the inch, and rejecting all that did not go through. The coarser particles were not wasted but were used around fruit trees, etc., where the nitrogen and phosphoric acid would slowly become available and utilized.

After all of the goods had been screened, samples for analysis were taken by the writer. The materials were then weighed out, and spread out in layers, one above the other, on the barn floor, care being taken to put the bulkiest materials at the bottom. They were then mixed by shoveling together four times and bagged. The writer took a sample of the mixed goods, and the

calculated composition and that found is given in the following table:

COMPOSITION OF A HOME MIXED "POTATO FERTILIZER," CALCULATED FROM THE MATERIALS USED, COMPARED WITH THE COMPOSITION OF THE MIXED GOODS AS FOUND BY CHEMICAL ANALYSIS.

	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Calculated	4.00	11.30	7.33
Found	3.91	11.02	7.38

This agreement between "calculated" and found" is closer than could always be expected, for it is indeed inside of the limits of errors in chemical analysis.

To see what would be the result if the sample of the ingredients were taken from unscreened goods in large lots, and shippers' weights assumed as correct, the following results were obtained in mixing by men without previous experience.

COMPOSITION OF A HOME MIXED "POTATO FERTILIZER" MADE FROM MANUFACTURERS' WEIGHTS OF GOODS, CALCULATED FROM THE ANALYSIS OF SAMPLES TAKEN AT RANDOM FROM THE STOCK OF CHEMICALS, COMPARED WITH THE COMPOSITION OF THE MIXED GOODS AS FOUND BY CHEMICAL ANALYSIS.

	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Calculated	4.3	10.2	7.3
Found	4.1	9.9	7.6

While these results do not agree nearly as well as in the case of the more carefully weighed and sampled goods, they run as close as many of the ready mixed goods sold in the State do to their guarantees.

The mechanical condition of these goods was excellent. They were used in the potato planter, and even in the old type Robbin's planter the fertilizer was distributed as freely and evenly as could be asked. The cottonseed meal and tankage were so dry that the use of a filler was unnecessary.

About 40 acres of potatoes were grown with the above home mixed goods, the fields being situated in three towns and two counties. The results will be given in detail in a bulletin now in preparation. The more general results are here briefly stated. In general large crops, ranging in Aroostook County from 275 to 380 bushels per acre, were obtained. On early planted potatoes, and where the season was long enough for the crop grown on the home mixture to mature, the yields were as large as where the standard commercial fertilizers were liberally used. The tops kept greener in color during the last half of the growing season with the home mixture. September 1 there was a severe frost all over Northern Maine. The late potatoes grown upon the home mixture had greener and more succulent vines than those upon the standard fertilizers and in consequence were damaged much more by the frost. In fact the vines of the late planted potatoes on the home mixed goods were practically killed at this time, while the same varieties planted at the same time upon the standard potato fertilizer continued to grow after this frost. As a result the potatoes were larger and better ripened with these than upon the home mixed plots. For quick maturing, the home mixed goods apparently carried too much slowly available nitrogen and too little available phosphoric acid—a condition that can be readily remedied in a formula.

KINDS OF INGREDIENTS.

There are various materials that are used in the manufacture of fertilizers, but because of Maine's distance from the commercial centers, it will rarely be profitable to purchase any but materials carrying high percentages of plant food. For instance, the cost of bagging, cartage and freight on a ton of muriate of potash, carrying 1000 pounds of actual potash, would be no greater than the freight on a ton of kainit carrying only 250 pounds of potash, and if the kainit could be bought for one-fourth the price of the muriate it would, because of the freight, still be the more expensive source of potash. Furthermore, in mixing and applying, four times as great weight would have to be handled.

The kinds of fertilizing materials that would usually be most profitable and economical sources of plant food for home mixing in Maine are given in the table which follows. It will be under-

stood that this class of goods is always sold under a guaranteed percentage composition, and the percentages here given are only approximate and for guidance in inquiry.

AVERAGE COMPOSITION OF CHIEF COMMERCIAL FERTILIZER MATERIALS.

	NITROGEN.	PHOSPHORIC ACID.		Potash — per cent.
	Per cent.	Available— per cent.	Total— per cent.	
Nitrate of soda	16	.....	.....	.....
Nitrate of potash	14	.....	.....	44
Sulphate of ammonia	20	.....	.....	.....
Dried blood, high grade	13	.....	.....	.....
Dried blood, low grade	10	.....	4	.....
Concentrated tankage	12	.....	1	.....
Bone tankage	5.5	.....	12	.....
Portland Rendering Co's tankage in 1904..	4.9	4.2	16.3	.....
Portland Rendering Co's tankage in 1904, screened	5.5	7.3	16.0	.....
Dried fish scrap	8	.....	7	.....
Cotton-seed meal	7	.....	1.5	2
Acid phosphate .....	.....	13	14	.....
Raw ground bone (bone meal)	4	8	22	.....
Steamed bone	2	9	25	.....
Muriate of potash .....	.....	.....	.....	50
Sulphate of potash (high grade) .....	.....	.....	.....	50
Kainit .....	.....	.....	.....	12
Hard wood ashes (unleached) .....	.....	.....	1	5
Hard wood ashes (leached) .....	.....	.....	1	2

Fertilizing materials should be dry and fine. If moist there is danger of their lumping. Not only the evenness of the mixture, but the availability of forms of plant food is directly dependent upon the fineness of the goods. Ground bone is only very slowly available unless it is finely ground. In ordering chemicals it should always be demanded that they be finely ground and in good mechanical condition, for the mixed goods will not be satisfactory for machine use unless the ingredients are in good shape.

In case no dry and bulky materials, e. g. cottonseed meal, or tankage, are used in the formula, it will be necessary to use some material such as dry loam, or "muck" as an absorbent and filler.

WHERE UNMIXED FERTILIZERS CAN BE PURCHASED.

Unmixed goods can be purchased in Maine from the Sagadahoc Fertilizer Company, Bowdoinham, The John Watson Company, Houlton, and the agents of the American Agricultural Chemical Co. Tankage can be had from the Portland Rendering Co., Portland. Out of the State unmixed goods can be obtained from the fertilizer manufacturers. The following Massachusetts Companies do business in this State: The American Agricultural Chemical Co., 92 State St., Boston, Mass.; The Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.; The New England Fertilizer Co., 44 North Market St., Boston, Mass.; The Parmenter & Polsley Fertilizer Co., Peabody, Mass.; The Russia Cement Co., Gloucester, Mass.; and Swifts Lowell Fertilizer Co., 43 North Market St., Boston, Mass.

Edmund Mortimer & Co., 13 William St., New York, N. Y., make a specialty of selling chemicals for home mixing.

PLANT FOOD REMOVED BY CROPS.

It serves as something of a guide in the application of fertilizers to know the requirements of different crops as measured by the amount of plant food that is removed by a single crop. Of course such figures are only approximate and can not be blindly followed. For instance the legumes, members of the pea and clover family, have the power of acquiring a very considerable part of their nitrogen from the air by the aid of minute organisms which form enlargements known as root tubercles upon the roots of this family of plants.* For this reason this class of plants, although among the richest in nitrogen, and removing large amounts of this fertilizing ingredient, can be grown by the use of mineral fertilizers carrying almost no nitrogen.

The table which follows gives the approximate amounts of nitrogen, phosphoric acid and potash that are removed by quite large yields of the more common farm crops. Not only the

* For a discussion of this see Report of this Station for 1897.

fruit, seeds, tubers, etc., are taken into account in the figures in the table, but the plant food removed in the tops, straw, etc., is considered as well.

THE APPROXIMATE AMOUNT OF NITROGEN, PHOSPHORIC ACID AND POTASH CONTAINED IN THE TOTAL YIELD OF DIFFERENT CROPS, INCLUDING STRAW, VINES, ETC., FROM ONE ACRE IN ONE YEAR.

Kind of Crop.	Yield per Acre.†	Nitrogen — pounds.	Phosphoric acid — pounds.	Potash — pounds.
Barley	40 bush.	74	23	68
Buckwheat	30 bush.	53	21	60
Oats	60 bush.	60	22	50
Wheat	30 bush.	62	20	26
Corn, ripened	60 bush. }	84	32	34
Corn fodder, green.....	12 tons. }			
Potatoes	300 bush.	55	25	85
Turnips	700 bush.	80	52	180
Beets.....	600 bush.	110	40	190
Clover hay*.....	3 tons.	123	27	132
Timothy and red top	3 tons.	69	27	58
Mixed hay (some clover)	3 tons.	84	21	93
Beans*	40 bush.	100	40	70

* Legumes that under favorable conditions derive a large part of their nitrogen from the air.

† Larger yields than the average are purposely given, but no larger than should be striven for as an average.

PLANT FOOD IN THE SOIL AND SOD.

The amount of available plant food in the soil has a very important bearing upon what should be applied. There is a wide spread belief that a chemical analysis of a soil will serve as a guide to the selection and use of fertilizers. While in a rare and occasional instance a chemical analysis will throw light upon the question of soil fertility, such an analysis is, unfortunately, of very little help in determining the needs of the soil for crop growing. The chemist can tell how much of each ingredient the soil contains, but cannot tell whether it is in avail-

able form. Moreover different plants have different feeding capacities, so that the plant food which would be available to one class of plants might not to another. This question can be best answered by putting it directly to the soil in a so-called soil test experiment.†

If a farmer has not experimented with his soil so that he knows to what fertilizing elements it most readily and profitably responds, he must be guided in the purchase of plant food by general principles. And this is as true in the purchase of mixed as unmixed goods. In either case there is considerable uncertainty. The purchase of unmixed goods, however, has the advantage that the farmer knows what he has used, and if he is observant and keeps record of his management, he will know where he made the mistake and how to avoid it the next season.

In addition to the plant food in the soil, the farmer has at his disposal the manure from the farm animals and a very considerable amount in that left in roots and stubble from the preceding crop. A few figures illustrative of this are given in the table which follows.

AMOUNT OF NITROGEN, PHOSPHORIC ACID AND POTASH LEFT IN THE ROOTS (TO THE DEPTH OF 6 INCHES) AND STUBBLE IN ONE ACRE AFTER THE CROP HAS BEEN REMOVED AND A NEW GROWTH HAS STARTED, AND IN FARM MANURE.

Kind of Plants.	Nitrogen, pounds.	Phosphoric acid, pounds.	Potash, pounds.
Timothy and red top, average of 2 experiments.....	62	15	31
Clover, average of 3 experiments.....	36	10	22
One ton, rich stable manure*	10	10	8

* Manure is extremely variable in composition and weight. A cord of manure will weigh from 3 to 4 tons. Farmers' Bulletin 192, of the U. S. Department of Agriculture, on farm manures, can be had free from your Congressman, or the Secretary of Agriculture, Washington, D. C.

† Circular No. 8 of the Office of Experiment Stations of the United States Department of Agriculture explains how such a test can be made. A postal card sent to the Secretary of Agriculture, Washington or to your Congressman will bring this circular free.

HOW TO MIX CHEMICALS FOR USE.

After the formula has been decided upon, and the chemicals purchased, the mixing is readily attended to in accordance with the following or some similar way.

The apparatus needed consists of: Tight floor; platform scales; shovel with square point; an iron hand rake, and a sand screen with 3 meshes to the inch (frame about $4\frac{1}{2}$ ft. by $1\frac{1}{2}$).

Screen all the materials. Pulverize all lumps and pass through the screen before adding to the pile. Nitrate of soda is apt to be lumpy. If emptied out, slightly moistened and allowed to stand over night, the lumps will fall apart on raking. When practicable the nitrate should be reground at time of purchase.

Spread the proper weight of the most bulky material on the floor to a depth of six inches. Make the top level and spread the proper weight of the next most bulky material on top of the first. Proceed in like manner until all the different constituents have been added to the pile. Shovel over the whole three or four times, taking care to carry the shovel to the bottom of the pile and to mix as thoroughly as possible. After the goods are mixed, they can be stored in bulk or put into bags or barrels until they are needed. It is usually much more economical of time for the farmer to mix the chemicals he may need before the rush of spring work. With well dried materials in good mechanical condition, the mixed goods will keep for months if stored in a dry place. It is better, however, to mix the goods as late as practicable without interfering with other work.

DEVISING FORMULAS.

Although the selection of a formula for home mixing fertilizers, like compounding rations for stock, is a good deal more than mere arithmetic, the data given in the tables on pages 135 and 137 are suggestive and will prove helpful. The correct use of commercial fertilizers involves the supply of plant food that a given soil lacks to produce a good yield of a given crop. Hence to fertilize to the best advantage, the soil to be used must be known.

All soils contain much more plant food than is needed to grow many crops. The larger part of this is not immediately avail-

able. It is a part of good farming to make this plant food available and in no way can this be as effectively brought about as by thorough preparation of the soil before planting and, in the case of hoed crops, by thorough cultivation during the growing season. The plant food in soil is, in general, available to growing plants in proportion to the smallness of the particles of soil. Too strong emphasis cannot be put upon the proper plowing, harrowing and other mechanical preparations of the soil and in the case of hoed crops, constant thorough cultivation during the growing season.

While recognizing the danger that may come from a blind following of definite directions for general practice, the following quite specific suggestions are made for a few general crops. *It is to be borne in mind in using these formulas that they are only suggestive and that different conditions of soil make such different treatment essential that a formula which may prove successful on one farm may not be equally so on another.*

In the suggested formulas the composition as given in the table on page 135 is assumed for the chemicals. The analysis of the Portland Rendering Companies screened tankage as found in 1904 and given in the table is used for the composition of tankage.

FORMULAS FOR POTATOES.

In 1904 there were licensed in Maine rather more than 40 brands of fertilizers in which the word potato entered into the name. It is very doubtful if in more than one-third of these brands there was any reason, other than the attraction of the name, to call them potato fertilizers. More than half of them have the composition of general purpose goods with about 3 per cent nitrogen, 8 per cent available phosphoric acid, and 3 per cent potash. Those that would be taken seriously as intended for potatoes carry less phosphoric acid and relatively more nitrogen and considerably more potash. Nearly all of the companies put out a brand with the word potato in its name that carries about 3.5 per cent nitrogen, 6 per cent available phosphoric acid and 8 or 10 per cent potash.

A crop of 300 bushels of potatoes will remove from the soil about 55 pounds of nitrogen, 25 pounds phosphoric acid and 85 pounds of potash. It is quite a common practice in Aroostook

County to use 1000 to 1200 pounds per acre of such a fertilizer as last named, which would furnish about two-thirds the required nitrogen for a 300 bushel crop, three times as much phosphoric acid and rather more than enough potash.

In general the potato plant thrives best in a soil abundantly supplied with all fertilizing elements. In the early stages of growth nitrogen is particularly demanded, and hence a considerable part of the nitrogen should be in water soluble form, so that it may be readily available early in the season. Later, when the tubers are forming, there is special demand for phosphoric acid and potash.

The formula used by a number of farmers in Cumberland and Aroostook Counties in 1904 at the rate of 900 to 1300 pounds per acre, and giving a yield from 100 to 140 barrels (275 to 380 bushels) per acre was as follows:

FORMULA (NO. 1) FOR 300 BUSHEL POTATOES, USED IN 1904.
SATISFACTORY WHERE THE SEASON WAS LONG ENOUGH TO
MATURE THE CROP. FOR ONE ACRE.

	Weight used — pounds.	Nitrogen — pounds.	PHOSPHORIC ACID.		Potash — pounds.
			Available — pounds.	Total — pounds.	
Tankage*	500	27.7	36.5†	80.2	.....
Cotton seed meal	200	13.7	.....	7.2	5.8
Nitrate of soda	100	14.7	.....	.....	.....
Acid phosphate	400	.....	68.2	71.0	.....
Sulphate of potash	200	.....	.....	.....	96.8
	1,400	56.1	104.7	158.4	102.6
Percentage composition		4.0	7.5	11.3	7.3
Percentage composition as used in Aroostook county*		4.3	7.4	10.2	7.3

*In the Aroostook county lots 420 pounds of a tankage with less phosphoric acid and more potash was used, with a resulting higher percentage of nitrogen and lower percentage of potash.

†This represents the amount of phosphoric acid that is "citrate soluble" as found by chemical analysis, but it is not as speedily available to the growing crop as that of acid phosphate.

The potash was applied in the form of sulphate instead of muriate because it is commonly held that the sulphate produces a better quality of potatoes. Unpublished results of experiments by this Station do not confirm this opinion. Although this formula did as well with early planted potatoes as the commercial fertilizers with which it was compared, it had a tendency to prolong the period of growth, with the result that on late potatoes, particularly in the northern part of Aroostook County, the vines were green and vigorous at the time of the first severe frost, which this year was early, September 1. The other parts of the fields, planted with the standard commercial fertilizers, stood the frost much better than these tenderer vines grown on the above formula. At digging, the yield with late planted potatoes was larger and the individual potatoes were larger and better matured on the standard brand of mixed goods than on the above formula. For late planting with a short season it would probably be advantageous to use a formula with more water soluble nitrogen and more available phosphoric acid, as an excess of this latter seems to hasten the ripening of the crop. Some such a formula as the following might be used:

A COMPLETE FORMULA (NO. 2) FOR 300 BUSHELS POTATOES. THE LARGE EXCESS OF PHOSPHORIC ACID WILL TEND TO EARLY MATURITY. FOR ONE ACRE.

	Weight used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda*	200	32	.....	.....	.....
Screened tankage.....	200	11	15	32	.....
High grade dried blood†.....	100	13	.....	.....	.....
Acid phosphate	500	.....	65	70	.....
Sulphate of potash	200	.....	.....	.....	100
Total	1,200	56	80	102	100
Percentage composition		4.7	6.7	8.5	8.3

* Seventy-five pounds of sulphate of ammonia could be well used in place of 100 pounds of the nitrate.

† 150 pounds ordinary dried blood or 200 pounds cotton seed meal might be used in place of the high grade dried blood.

If the potatoes are to be grown on sod land and a good stubble of clover or mixed grasses with the aftermath has been plowed under, or if stable manure is used, much of the organic nitrogen needed for the crop will, as shown in the table on page 138 be supplied by either of these materials. Under such conditions a formula containing nitrate and only a small amount of other nitrogen would doubtless give good results. Some such a formula as the following could be used:

FORMULA (NO. 3) FOR 300 BUSHELS POTATOES, TO BE USED ON SOD LAND WHERE A GOOD STUBBLE AND AFTERMATH HAS BEEN PLOWED UNDER, OR IN CONNECTION WITH FARM MANURES. FOR ONE ACRE.

	Weight used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda	100	16	.....	.....	.....
Screened tankage	200	11	15	32	.....
Acid phosphate	300	.....	39	42	.....
Sulphate of potash	200	.....	.....	.....	100
Total	800	27	54	74	100
Percentage composition		3.4	6.8	9.2	12.5

The tankage in the above will be sufficient to keep the fertilizer in good mechanical condition without the use of a filler.

CORN.

Corn is a crop that uses a large amount of nitrogen. It is usually grown upon sod land, or with farm manure, or both. Indeed, it is doubtful if under ordinary conditions it would prove a profitable crop to be grown on somewhat exhausted soil with commercial fertilizers alone. Experiments at the Massachusetts Station indicate that it does best with an excess of potash. Three formulas are suggested for use on sod land and in conjunction with farm manure. In the first of the following formulas the materials will not of themselves make a good dry

mixture for machine planting. Two or three hundred pounds of dry loam, muck, or other suitable material will be needed to mix with the chemicals to make a mixture in good mechanical condition. The first formula contains only about one-sixth of the nitrogen needed to grow the crop. With a good sod and especially with a liberal dressing of farm manure, that will be all that is needed. The second and third formulas carry more nitrogen and the dry bulky tankage or cottonseed meal do away with the necessity of a filler.

FORMULAS FOR CORN ON SOD LAND OR IN CONJUNCTION WITH
FARM MANURE. FOR ONE ACRE.

	Weight used —pounds.	Nitrogen —pounds.	PHOSPHORIC ACID.		Potash —pounds.
			Available —pounds.	Total —pounds.	
(No. 4.)					
Nitrate of soda	100	16	.....	.....	.....
Acid phosphate	400	.....	52	64	.....
Muriate of potash.....	150	.....	.....	.....	75
Total	650	16	52	64	75
Percentage composition .....	.....	2.5	8.0	9.9	11.5
(No. 5.)					
Nitrate of soda	100	16	.....	.....	.....
Screened tankage	200	11	15	32	.....
Acid phosphate	300	.....	39	42	.....
Muriate of potash.....	150	.....	.....	.....	75
Total	750	27	64	74	75
Percentage composition .....	.....	3.7	8.5	9.9	10.0
(No. 6.)					
Nitrate of soda	100	16	.....	.....	.....
Cotton seed meal	200	14	.....	3	4
Acid phosphate	400	.....	52	64	.....
Muriate of potash.....	150	.....	.....	.....	75
Total	850	30	52	67	104
Percentage composition .....	.....	3.5	6.1	7.9	12.2

SEEDING TO GRASS.

In this State spring seeding, with a shade crop of grain, (usually oats) is the common practice. Summer seeding is practiced to some extent, but does not fit in to the usual rotation as well as spring seeding. It is doubtful if it is profitable to grow oats or wheat in this State except as a nurse crop for grass. They are exhaustive of plant food, particularly nitrogen, and in proportion to the value of the crop are costly to grow. In spring seeding with grain it is, of course, necessary to take the demands of the grain as well as the grasses into account in selecting a fertilizer. Where seeding follows corn in the rotation, it usually happens that all of the farm manure is used on the corn crop, and all the plant food for the grasses must be otherwise provided. Where potatoes precede seeding, however, usually farm manure can be used in seeding down. The old, and still by far more common way, is to seed with rather slowly available fertilizers, and crop the field until the grass yield is too small to be profitable. A better way is to fertilize the land annually and in case it is desired to keep the field in grass more than one or two years to top dress with soluble commercial fertilizers. Based upon these various methods of treatment and taking into account the amounts of fertilizing materials removed by each crop (see page 137), the following formulas are suggested. It should be remembered that thorough preparation of the soil is as essential with grass as any crop.

A FORMULA (NO. 7) FOR SPRING SEEDING WITH OATS AS A NURSE CROP IN CONJUNCTION WITH LIBERAL APPLICATIONS OF FARM MANURE.* FOR ONE ACRE.

	Weights used— pounds.	Nitrogen —pounds.	PHOSPHORIC ACID.		Potash —pounds.
			Available —pounds.	Total —pounds.	
Nitrate of soda	100	16	.....	.....	.....
Acid phosphate	400	.....	52	56	.....
Muriate of potash.....	250	.....	.....	.....	125
Total	750	16	52	56	125
Percentage composition .....	.....	2.1	6.9	7.5	16.5

* If desired to apply by machinery, it would be necessary to mix with about 200 pounds of some fine, dry material, as muck, or loam.

A FORMULA (NO. 8) FOR SPRING SEEDING WITH OATS WITHOUT
FARM MANURE. FOR ONE ACRE.

	Weights used —pounds.	Nitrogen —pounds.	PHOSPHORIC ACID.		Potash —pounds.
			Available —pounds.	Total —pounds.	
Nitrate of soda	100	16	.....	.....	.....
Screened tankage.....	500	28	36	80	.....
Acid phosphate	200	.....	26	28	.....
Muriate of potash.....	250	.....	.....	.....	125
Total	1,050	44	62	108	125
Percentage composition .....	.....	4.2	5.9	10.3	11.9

This will make a dry fertilizer that can be applied with machinery.

A FORMULA (NO. 9) FOR SUMMER OR FALL SEEDING WITH
FARM MANURE. FOR ONE ACRE. AT SEEDING.

	Weights used —pounds.	Nitrogen —pounds.	PHOSPHORIC ACID.		Potash —pounds.
			Available —pounds.	Total —pounds.	
Acid phosphate	100	.....	13	14	.....
Muriate	170	.....	.....	.....	38
Total	270	.....	13	14	38
Percentage composition.....	.....	.....	6.5	7	19

The following spring apply

Nitrate of soda	100	16	.....	.....	.....
Acid phosphate	200	.....	26	28	.....
Muriate	250	.....	.....	.....	100
Total	450	16	26	28	100
Percentage composition .....	.....	3.6	5.8	6.2	22.2

A FORMULA (NO. 10) FOR SUMMER OR FALL SEEDING WITHOUT
FARM MANURE. FOR ONE ACRE. AT SEEDING.

	Weights used — pounds.	Nitrogen — pounds.	PHOSPHORIC ACID.		Potash — pounds.
			Available — pounds.	Total — pounds.	
Nitrate of soda	100	16	.....	.....	.....
Screened tankage.....	400	22	29	64	.....
Muriate of potash.....	100	.....	.....	.....	50
Total	600	38	29	64	50
Percentage composition .....	.....	6.3	4.8	10.7	8.3

The following spring apply the chemicals suggested for use with formula 9.

The Rhode Island Station has experimented with top dressing for grass for a series of years and has found it profitable. Of course it should not be practiced unless there is a good stand of grass plants. It recommends the following:

FORMULA (NO. 11) FOR SPRING TOP DRESSING GRASS LAND,
SUGGESTED BY THE RHODE ISLAND EXPERIMENT STATION.*

	Weights used — pounds.	Nitrogen — pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda	350	54	.....	.....	.....
Acid phosphate	400	.....	52	56	.....
Muriate of potash.....	250	.....	.....	.....	125
Total	1,000	54	52	56	125
Percentage composition .....	.....	6.8	6.5	7.0	15.6

* Bulletin 90, Rhode Island Experiment Station.

THE LEGUMES.

The family of the legumes, which include such plants as clover, peas, vetches and beans, carry much higher percentages of nitrogen than most other plants and differ, so far as known, from all other plants in that they can obtain all or practically all their nitrogen from the free nitrogen of the air. This they cannot do directly, but by the assistance of minute organisms which grow upon their roots. (See page 136). In order to thus acquire nitrogen it is necessary that the soil contain the proper organism, usually a different kind for each legume. If the soil is not stocked with the proper organism it can be, either by applying soil from a field known to carry them, or by "cultures." The soil almost everywhere in Maine is stocked with the organisms that work upon clover, peas and beans. Because of their power under these conditions to acquire the larger part of their nitrogen from the air, the legumes can be fertilized very differently, and at less cost than other plants. Formulas, carrying a little nitrogen to give the plants a start, and furnishing the needed minerals for the crop, follow. To make these in sufficiently good mechanical condition for use in machinery, they need to be mixed with about 150 pounds fine dry muck, loam or similar materials.

A SUGGESTED FORMULA (NO. 12) FOR THE CLOVERS, OR ALFALFA WITHOUT OTHER MANURE AND ON LAND CARRYING THE PROPER ROOT TUBERCLE ORGANISMS. FOR ONE ACRE.

	Weights used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda	50	8	.....	.....	.....
Acid phosphate	400	.....	52	56	.....
Muriate of potash.....	250	.....	.....	.....	125
Total	700	8	52	56	125
Percentage composition .....	.....	1.1	7.4	8.0	17.9

A SUGGESTED FORMULA (NO. 13) FOR BEANS OR PEAS WITHOUT THE MANURE ON SOIL CARRYING THE PROPER ROOT TUBERCLE ORGANISMS. FOR ONE ACRE.

	Weights used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda	50	8	.....	.....	.....
Acid phosphate	400	.....	52	56	.....
Muriate of potash.....	150	.....	.....	.....	75
Total	600	8	52	56	75
Percentage composition .....	.....	1.3	8.7	9.3	12.5

BEETS. MANGOLDS.

A crop of 600 bushels of beets carries more than 100 pounds of nitrogen, nearly 200 pounds potash, and only about 40 pounds phosphoric acid. At the Rothamsted (England) Experiment Station mangolds have been grown continuously on the same land for nearly 30 years with different fertilizers. The results of the experiments are summarized as follows:*

“Mangolds can be grown continuously on the same land without injuring the tilth of the land or the health of the crop.

“A liberal dressing of farmyard manure forms the best basis of the manure for mangolds.

“The crop will further respond to considerable additions of active nitrogenous manures to the dung, particularly of nitrate of soda.

“A free supply of potash salts is essential to the proper development of the mangold, hence a specific potash manuring is desirable, even when dung is used in large quantities, and on a strong soil initially rich in potash. When nitrogenous manures are used in addition to dung, the potash salts should be increased pro rata, in order to maintain the health and feeding value of the crop and to bring it to maturity.

* Farm Journal of Royal Agricultural Society, 1902.

"In conjunction with dung, phosphatic manure is hardly necessary and will give little appreciable return especially when the crop is grown in rotation.

"As soluble alkaline salts are beneficial to the mangold crop, either as direct foods or economizers of potash, a dressing of salt should always be included among the manures for the mangold crop."

Based upon these findings, a liberal dressing for mangolds would be about 5 cords of good stable manure and the chemicals named in the following formula.

A FORMULA (NO. 14) FOR MANGOLDS OR OTHER BEETS, BASED UPON EXPERIMENTS AT THE ROTHAMSTED (ENGLAND) EXPERIMENT STATION. TO BE USED IN CONJUNCTION WITH A LIBERAL DRESSING OF FARM MANURE. FOR ONE ACRE.

	Weights used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available— pounds.	Total— pounds.	
Nitrate of soda	400	64	.....	.....	.....
Muriate of potash.....	400	.....	.....	.....	200
Common salt*	200	.....	.....	.....	.....
Total	1,000	64	.....	.....	200
Percentage composition .....	.....	6.4	.....	.....	20

* Beets are successfully grown in Maine without salt.

This can be conveniently applied broadcast, separately. To avoid loss by leaching, only part of the nitrate of soda should be applied at planting and the remainder when the plants are well established. To use in machinery, mix with 200 to 300 pounds fine dry muck or loam.

If stable manure is not used, 40 pounds screened tankage, 400 pounds high grade dried blood (250 pounds of sulphate of ammonia can be used instead of the dried blood), and 200 pounds acid phosphate can be used to replace the manure. This formula has not been put to a practical test and is based in part upon the plant food requirements of the crop and in part upon the experience at Rothamsted.

A FORMULA (NO. 15) FOR MANGOLDS OR OTHER BEETS WITHOUT FARM MANURE. FOR ONE ACRE.

	Weights used— pounds.	Nitrogen— pounds.	PHOSPHORIC ACID.		Potash— pounds.
			Available — pounds.	Total— pounds.	
Nitrate of soda	200	32	.....	.....	.....
Screened tankage	800	44	58	128	.....
Sulphate of ammonia (or 300 lbs. high grade dried blood)	200	40	.....	.....	50
Acid phosphate	200	.....	26	28	.....
Muriate of potash	400	.....	.....	.....	200
Common salt	200	.....	.....	.....	.....
Total	2,000	116	84	156	200
Percentage composition . . . . .	.....	5.8	4.2	7.8	10

FERTILIZERS IN ROTATION.

As an illustration of the use of manure and commercial fertilizers in a rotation, the following, based upon successful farm practice on rather heavy loam of retentive character, is suggestive.

First year. Potatoes on sod land.

Second year. Corn for silage.

Third year. Seeding with oats.

Fourth year. Hay.

Fifth year. Hay or pasturage.

First year. Plant with potatoes on sod land, early plowed the preceding fall and worked to a good seed bed. Apply formula No. 3, page 143 in the drill at planting. A crop of 250 to 300 bushels will have removed all the plant food of the commercial fertilizer and much of that of the sod.

Second year. Corn on stable manure and commercial fertilizer. Plow the land preceding fall. Apply the farm manure in the spring broadcast and work in with disc or other suitable harrow. Apply formula No. 4 on page 144 if 5 cords of farm manure have been used per acre, or No. 5 or No. 6 if less. A

crop of 12 to 15 tons of silage corn will have used up the nitrogen of the commercial fertilizers; part of the nitrogen of the manure and considerable phosphoric acid and potash will be left available for the next season's crop.

Third year. Seeding to grass with oats. The land is to be plowed the preceding fall. If it can be spared, topdress with about 3 cords of farm manure and use formula No. 7, page 145. If farm manure is not available, use formula No. 8, page 146. The farm manure, if used, is applied and worked in as for corn the preceding year. For grass, the land must be thoroughly worked, the surface kept true and a good seed bed prepared. Upon the heavy clay loam land at the University the following mixture has proven successful for spring seeding: Oats, 5 pecks; timothy 10 pounds; red top 7 pounds; alsike clover 6 pounds. In most seasons the grass will do better if the oats are cut green (in milk) for fodder or hay. Oat hay at best is a poor kind of hay, although if cock cured it makes a hay that will be cleanly eaten. It may be, even at the expense of the grass, best to allow the oats to ripen. Keep teams off the field as far as possible and do not turn stock into it nor cut it, even though the clover does look tempting.

Fourth year. Top dress early in the spring with 200 pounds of acid phosphate and 100 pounds of muriate of potash. As the application of nitrate of soda has a tendency to run out clover, in a five-year rotation it will be better to top dress with minerals only. If it is desired to maintain the field for hay for several years, formula No. 11, page 147 can be advantageously used. Unless there is an unusually early aftermath, do not cut a second crop or feed if the field is to be used for hay the next year.

Fifth year. Top dress as the preceding year and pasture or cut for hay.

If the preceding program is carried out with ordinary seasons, good crops should be obtained and the land should be in better fertility at the end than at the beginning, five years before.

